## REMARKS

Claims 1, 3-6 and 9-14 are currently pending in the application, claim 2 having been canceled in response to a prior restriction requirement, the limitations of claim 7 having been incorporated into claim 1 and claims 8 and 15-22 having been canceled and included in a divisional application. By this amendment claim 1 is further amended for the Examiner's consideration, and claims 10, 12, 13 and 14 are amended in accordance with the Examiner's instructions. The foregoing separate sheets marked as "Listing of Claims" shows all the claims in the application, with an indication of the current status of each.

The Examiner's indication that claims 10-11 and 13-14 contain allowable subject matter is acknowledged with appreciation. The Examiner's objections to certain informalities in these claims are overcome by the present amendment.

The Examiner has withdrawn claim 12 as being drawn to non-elected invention and species. However, it appears that claim 12 depends from claim 1 in the same manner that claim 11 depends from claim 1, the refractive indices of the various layers being related in accordance with claim 1. Therefore it is submitted that the Examiner's withdrawal is mistaken and claim 12 should be restored, and allowed.

The Examiner has rejected claims 1, 3, 4 and 9 under 35 U.S.C. §102(b) as being anticipated by Japanese Patent 2-225345 to Kawaguchi et al. ("Kawaguchi"). The Examiner asserts that Kawaguchi discloses an optical filter that comprises a plurality of dielectric materials alternatively arranged on a transparent substrate to form a laminate, wherein said filter includes a first dielectric group having a low index of refraction, a second dielectric group having a high index of refraction and a third dielectric group having an intermediate index of refraction, serving as the outermost surface of the filter. However, all that is evident from the disclosure is alternating layers of high and low refractive index material, the high refractive index material being $TiO_2$ and the low refractive index material being $SiO_2$, where the

resulting laminate is coated with a $SnO_2$ layer, which serves as the outermost layer (Abstract of patent 02225345). It is not indicated what the refractive index of the $SnO_2$ layer is, relative to the other layers. Consequently, the Examiner has not met his burden of proof as to all the elements of claim 1, namely, as regards the refractive index of the third layer relative to the refractive index of the layers in the first and second groups of dielectric thin films. Furthermore, as will be shown below, it is believed that the $SnO_2$ layer has a relatively high index of refraction and therefore cannot serve as the third layer of the present invention. The Kawaguchi reference is concerned with the thicknesses of the various layers, and gives no indication of any particular values of the refractive index for any layers. For example, Table 1 shows film thickness but gives no indication of values for the refractive index for any layers. Further, the text of Kawaguchi is replete with thickness measures and ranges of thickness, but does not recite values for the refractive index of any layer.

Consequently, it is submitted that Kawaguchi is overcome as a 102 reference.

However, the present invention is basically directed toward applying laminated structures to polarization filters, a teaching not provided by the cited prior art. Consequently, whether or not the Examiner provides further information in order to justify maintaining Kawaguchi as a 102 reference, the applicant by this amendment adds a limitation to claim 1 making explicit the use of the claimed laminate structure as a polarizing filter. In particular, as described at page 7, line 12, to page 8, line 1, the invention reflects the observation that a multilayer film configuration can turn "non-polarized light with a certain wavelength" into polarized "light in which the transmittance ratio of the s-polarized light component to the p-polarized light component is in the range of 1:1 to 1:5" (or 1.0 to 0.2). It is respectfully submitted that this polarization filter limitation distinguishes the present invention from the prior art of record.

The Examiner has rejected claims 1, 3, 4 and 9 under 35 U.S.C. §102(b) as being anticipated by French Patent 2,713,624 ("French Patent '624"). The Examiner

asserts that French Patent '624 discloses an optical filter comprising a plurality of dielectric materials alternatively arranged on a transparent substrate to form a laminate, wherein said filter includes a first dielectric group having a low index of refraction, a second dielectric group having a high index of refraction and a third dielectric layer having an intermediate index of refraction, serving as the outermost surface of the filter. Here, again, the Examiner has not established a *prima facie* case under 35 U.S.C. §102(b). French Patent '624 relates to thin anti-reflecting layers having improved performance in fields other than in optics, and in particular resistence to scratches and chemicals. The applicant relies upon an automated translation of French Patent '624 provided by the SYSTRAN global language pack (attached as Appendix A) for the quotations provided below.

In French Patent '624, the anti-reflecting feature is to improve the visibility of objects placed behind the transparent substrate protected by the thin layers, which is obtained under the prior art as taught by the French Patent '624 by "alternations of layers of indexes of refraction strong and weak, finish on the surface a not very high index" (French Patent '624 at page 2, lines 18-20), but "in which the surface index is higher than that of the subjacent layer" (page 3, lines 2-6). However, nothing is said about the relative refractive index with respect to layers other than the "subjacent" layer, whereas the present invention is very specific that the third layer must have a refractive index higher than any in the first group and lower than any in the second group.

The solution presented by the French Patent '624 is "a stacking of dielectric layers of indices of refraction alternatively strong and weak in which the stacking is covered with an additional layer having a thickness higher than 5 nm and whose index of refraction is higher than 1.7" (page 5, lines 3-9). Indeed, the teaching of the French Patent '624 is that the outermost surface is "a layer of rather high index" (page 5, lines 18-23) which has the advantage of widening the range of possible materials for

the outermost surface layer, "which can thus improve in particular the performance of behavior to the chemical attack and abrasion of the product."

In summary, therefore, the novel contribution of the French Patent '624 teaches away from the present invention, and the recitation of the prior art in the French Patent '624 fails to provide a *prima facie* description meeting all the elements of claim 1 in the detail recited in the claim, and is therefore overcome as a reference under 35 U.S.C. §102(b).

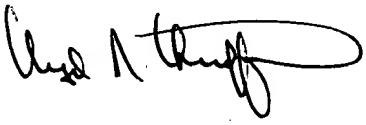
The Examiner has rejected claims 5 and 6 under 35 U.S.C. §103(a) as being unpatentable over Kawaguchi or French Patent '624 in view of U.S. Patent No. 4,627,688 to Kobayashi et al. ("Kobayashi"). In view of the foregoing discussion it is believed that amended claim 1 is allowable over either Kawaguchi or the French Patent '624, and therefore all claims dependent therefrom (i.e. all remaining claims, including claims 5 and 6) are also allowable. It should be noted that Kobayashi discloses a beam splitter having no third layer as contemplated by the present invention, instead teaching an uppermost layer of low refractive index.

In view of the foregoing, it is requested that the application be reconsidered, that claims 1, 3-6 and 9-14 be allowed, and that the application be passed to issue.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at 703-787-9400 (fax: 703-787-7557; email: clyde@wcc-ip.com) to discuss any other changes deemed necessary in a telephonic or personal interview.

If an extension of time is required for this response to be considered as being timely filed, a conditional petition is hereby made for such extension of time. Please charge any deficiencies in fees and credit any overpayment of fees to Attorney's Deposit Account No. 50-2041.

Respectfully submitted,



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# ANTI-REFLECTING THIN LAYERS

[Page 1, line 8, of French Patent] The invention relates to the anti-reflecting thin layers deposited on a transparent substrate and more particularly those obtained by cathode sputtering. It relates to in particular the layers with better performances in the fields other than optics and in particular with a scratch resistance improved and a chemical resistance.

[1,15] The anti-reflecting layers deposited on transparent substrates, glass or plastic have obviously as a function to decrease the reflection and thus to improve the luminous transmission and, by increasing the ratio light transmitted compared to the reflected light, to improve the visibility of the objects placed behind the transparent substrate which it generally has the role of protecting.

[1,22] In the field of the applications of the everyday life, it is for example about a fragile table lit by a light which comes from behind the observer. Another application is that of the windows of stores. When the windows are anti-reflecting, they make it possible to see easily what is inside the window, even when interior lighting is weak compared to the external light. The application to glasses of glasses is also well known, the function first is here also to make it possible to see the glance of the person who carries glasses under all the conditions of illumination and orientation.

[1,34] Apart from instrumental optics, in all the fields, the principle thus consists in making "disappear" the transparent substrate: it is necessary that from the point of view of the vision of the objects located behind him, all occurs as if the transparent substrate were not there. It is thus essential to prevent that one sees it "reappearing" because stains, fingerprints or degradation: final like stripes or a chemical attack localized is visible on treated surface. For die barrasser of the stains and finger marks, it is necessary to often clean the transparent panel and if the coating is not resistant, cleaning will involve the appearance of stripes and moreover, the products of cleaning will be able to attack it chemically. The good behavior with abrasion and chemical resistance are consequently essential qualities.

[2,11] Generally, one would like to often bring to anti-reflecting layers of the properties other than the optical properties. It is a question for example of making the whole conducting of electricity or of bringing properties to him hydrophobic or - on the contrary - absorbent, etc...

[2,17] It is that the multi-layer interferential ones intended to have an anti-reflecting action, which consists of alternations of layers of indexes of refraction strong and weak, finish with on the surface a not very high index. This constraint of the limited choice of the index limits the choice of possible materials for the surface layer such sets, thus for example the conducting layers such as ITO or Sn02 doped with fluorine has indices of about 2, incompatible with the existing anti-reflecting layers, in the same way one finds, with an exception, in this range of indices, no material with a good chemical resistance nor with a good behavior to the stripe. Only the layers of SiO2 with an index of 1,45 could bring a solution to chemical resistance or with abrasion but it is that to have a powerful layer, it should be deposited very slowly what limits the industrial exploitation such layers. On the contrary, of materials known for their good scratch resistance and a good chemical behavior and which settle quickly are to have an average or raised index of refraction and as such are even used like lay down surface interferential stackings intended to give to the reflection of the substrate a color and/or a strong intensity

[3,2] The goal of the invention is to allow the realization of made alternation of layers of index forts and weak stackings of anti-reflecting interferential layers in which the surface index is higher than that of the subjacent layer.

[3,7] The invention is more especially given for task to improve chemical resistance and the behavior with the stripe of anti-reflecting interferential stackings and a more general way it seeks the means of widening the range of possible materials like lay down surface anti-reflecting stackings.

[3,13] The invention must allow the dimension, implementation of the anti-reflecting layers improved by a technique of cathode sputtering exploitable on industrial lines great and weak coùts.

[3,17] The multi-layer interferential ones intended to decrease the coefficient of reflection of the surface of transparent substrates are known for a very long time, simplest have 3 component layers but larger numbers of layers are also very current.

[3,22] The patent applications European EP-A-0 258.831 and EP-A-0 263.541 describe one and the other of multi-layer anti-reflecting deposited by vacuum thermal evaporation on the front face of cathode ray tubes. The first of these documents proposes the successive deposit of three layers: Al2O3 (n=1,63), Ta2O5 (n=2,10) and finally a layer of low index, MgF2 (n=1,38). In spite of the use of a relatively hard and chemically stable material, Ta2O5 this stacking does not have a good behavior at abrasion or the chemical attack. It goes from there differently from stacking described in EP-A-0 263.541 which also associates three layers of index successively, means: Al2O3 (n=1,63), extremely: Nb2O5. (n=2,10), and weak: Si02 (n=1,45) to which one made undergo a heat treatment. This one provides to the evaporated layers a sensitive improvement of their performances. However, the techniques of vacuum evaporation are not adapted to the production of large-sized glazings under economic conditions. In addition, the additional phase of heat treatment is a constraint which one would like to free oneself.

[4,3] The techniques of cathode sputtering were however used to carry out assemblies of interferential layers of indexes of refraction alternatively strong and weak.

[4,7] Le document DE-A-39 41.797 shows several examples of anti-reflecting sets of five layers of indices alternatively strong and weak realized by reactive cathode sputtering. In all the examples, the surface layer has an index with most equal to 1,70, it is in particular of Al2O3 or SiO2. It should be noted that the layers of Al2O3, hard layers of average index, are very difficult to produce by techniques of cathode sputtering. As for the layers of SiO2 one saw that when they are deposited under conditions industrialist them, their performances of chemical behavior or anti-abrasive are limited.

[4,19] Generally, it was seen, all the anti-reflecting sets of layers consisted the alternation of unit layers of fort and weak index of refraction finishes with on the surface a weak layer of index such as a layer of MgF2 (index 1,36) or of SiO2 (1,48) exceptionally as in DE-A-39 41.797, it is about an average index. The components of multi-layer are, on the basis of glass, an oxide of strong index then a weak oxide of index and finally on the surface, an oxide of TaaO tantalum. or a mixed oxide tantalum/titanium. The presence, as lays down surface materials of high index (Ta2O3 has an index about n=2,15) very largely widens the choice of possible materials. Unfortunately, combinations of this the existing type are conceived to reinforce the coefficient of reflection of the substrate at least in certain ranges wavelengths instead of decreasing it.

[5,3] The invention relates to an anti-reflecting transparent product made up of a transparent substrate comprising on at least one of its faces, a stacking of dielectric layers of indexes of refraction alternatively strong and weak in which stacking is covered with an additional layer a thickness higher than 5 Nm and whose index of refraction is higher than 1,70. A means preferred to carry out the invention consists of what the difference of the indexes of refraction respectively strong and low of the dielectric layers constituting stacking is higher than 0,9. This condition indeed makes it possible to keep with the surface layer a sufficient thickness so that it is effective in its function. Preferably, the stacking of dielectric layers comprises four layers.

[5,18] The combination of alternate layers of forts and weak indices with as lay down surface a layer of rather high index makes it possible to very largely widen the range of possible materials for this surcouche which can thus improve in particular the performances of behavior to the chemical attack and the abrasion of the product. The broad choice of surface layers available thanks to the invention makes it possible to widen the range of the applications like layers anti-reflecting conducting or anti-static, absorbent or hydrophobic, etc... What is surprising, it is that it was possible to construct a powerful anti-reflecting whole in spite of this high index which opens a broad choice of materials.

[5,31] In an alternative of the invention, the surface layer is a hard layer such as a layer containing oxynitrided of SiOxNy silicon or oxide Ta2O5 tantalum.

[5,35] In another alternative, the surface layer is consisted a conducting layer such as a layer of ITO.

[5,37] The invention also relates to a process to deposit on a transparent substrate a whole of anti-reflecting interferential layers including/understanding the successive deposit of layers of indices alternatively strong and weak in which one finishes by the deposit of a surface layer of superscript than 1,70. This process is preferably implemented by the technique of cathode sputtering.

[6,7] The invention also relates to the application of the substrate equipped with anti-reflecting layers whose surface layer is a hard layer of superscript than 1,70 with the realization of windows, glasses or protective glazings of instruments or tables. It relates to also the application of the anti-reflecting product to conducting layer to the realization of front faces of screens, in particular of flat-faced screens.

[6,15] Description and the figure will make it possible to include/understand the operation of the invention.

[6,17] the figure represents a transparent substrate equipped with the same system of layers on the two faces.

N ' 1 EXAMPLE

[6,20] A sample of glass float clearly a 4 mm thickness and a dimension of 30x30 cm2 is introduced into an enclosure of cathode sputtering equipped with a system of horizontal transport of the samples which makes them pass under cathodes of pulverization to magnetrons equipped with targets for reactive pulverization. Among those, one at least is conceived so as to allow the reactive insulating material deposit, it can be a cathode equipped with a power supply in radio frequency (RF) or a rotary cathode for example of the type describes in the European patent application EP-A-0 461.035 or - preferably - a cathode known as "TWIN-MAG" with two elements fed in opposed alternating voltages, type of that described in patent US-5 082.546, all three systems whose function is to prevent that the metal target does not overlap with

material to deposit by reactive pulverization when it is insulator electrical. These precautions are to be taken in particular to deposit SiO2, SIOxNy and to a lesser extent TiO2. In the enclosure such a cathode is equipped with a metal silicon target, another out of titanium. The gases are argon, oxygen and the nitrogen.

[7,3] Before introduction into the enclosure, glass 7 underwent usual cleaning. The first layer is the reactive titanium oxide, the target is out of titanium and the atmosphere is a mixture of argon and oxygen. One deposits on glass a first layer (TiO.) a thickness of 12 Nm, it is layer 1 on the figure, it second layer is also an oxide, the silicon SiO2 oxide, the thickness of layer 2 is 37 Nm, the following layer 3 is of comparable nature that layer 1 and lays down it 4 of comparable nature that 2, their respective thicknesses are 116 Nm for TiO2, (3) and 76 Nm for SiO2 (4). The whole of these 4 layers constitutes V stacking 5 of layers of indexes of refraction alternatively strong and weak, indeed silica has a weak index, 1,48, slightly lower than that of glass (1,52) while TiO2, with 2,45 is definitely higher. On this basic stacking 5, one deposits layer 6 of the invention. It is a hard layer into oxynitrided of silicon carried out with same cathode as layers 2 and 4, equipped with the same target but here, the reactive gas added to argon is a mixture oxygen-nitrogenizes. The thickness to be given to layer 6 is 8 Nm.

[7,24] At the end of the deposit of layer 6, the sample left the enclosure and turned over so as to allow the deposit of a system of identical layers on the other face of substrate 7. One deposits successively layers 11, 12, 13 and 14 identical respectively to layers 1, 2, 3 and 4. They constitute the second stacking 15 of layers of indexes of refraction alternatively strong and weak. It is on this stacking that a layer 16, lasts with a superscript than 1,70 is deposited, they are as for layer 6 SiOxNy whose index is 1,80 and the thickness 8 Nm.

[7,35] Substrate 7 equipped with its two systems of identical layers comprising stacking 5, 15 covered with the hard layers 6, 16 was optimized from the point of view thicknesses of the layers by using a software of modeling, it acted of FILM * CALC 3.0 of FTG Software Associates de Princeton in the UNITED STATES. Modeling had

predicted a coefficient of reflection for the visible light (R) of 0,4% (instead of 8% for naked glass). The experimental result was 0,8%. It is obviously identical in the two directions.

[8,6] The treated sample as one has just seen it was subjected to the usual tests abrasion and of chemical attack (attacks acid with HCl) the two results are excellent.

[8,10] The system of layers which has been just described provides a surprising result. Indeed, since the anti-reflecting treatments of surfaces by interferential layers exist and since one alternates strong index and weak index, it is constant that the index of the surface layer is a weak index (and contrary, if the whole of the interferential layers must reinforce the reflection, the surface layer always has a strong index). The fact of obtaining a good anti-reflecting result (0,8% for the two faces) with on the surface an index means-extremely is very astonishing.

[8,21] The double symmetrical system that one has just described such as it is appropriate for a substrate out of glass or out of transparent plastic whose two reflective faces must be treated is appropriate, if it are used to only treat the front face of a screen, flat-faced screen or CRT, the coefficient of reflection obtained is even weaker. The whole of .couches interferential of strong and weak indices alternate can also be associated other layers, layers absorbing and/or conducting like layers of nickel-chromium or Chock for example.

EXAMPLE N ° 2

[8,31] The cathodic spraying installation used to construct the whole of interferential layers of this example is the same one as to produce that of example 1, one installed only one additional cathode cd. with a tantalum target.

[8,37] The following table alternatively gives the composition of the stacking of dielectric layers of index of basic refraction strong and weak. The nature of the layers is the same one as in example 1. The substrate is here also a float glass of index 1, 52. The numbers are those of the reference marks of the figure.

| Natural | number | Index N | Thickness (Nm): physical |
|---|---|---|---|
| 1 | $TiO_2$ | 2,45 | 9 |
| 2 | $Si0_2$ | 1,48 | 61 |
| 3 | $TiO_2$ | 2,45 | 103 |
| 4 | $SiO_2$ | 1,48 | 61 |

[9,18] The last layer, that which is placed on the surface of preceding stacking is here out of oxide Ta2O5 tantalum, it is obtained by reactive pulverization cd. with a magnetron equipped with a metal tantalum target. The gas is argon with oxygen. The physical thickness of the layer necessary to obtaining a correct anti-reflecting effect is of 9 Nm (index of Ta2O5, 2,15). It is modeling with the same method as previously which made it possible - knowing the indexes of refraction of the layers - to determine their respective thicknesses by seeking the low possible result for the coefficient of reflection without the 5th layer, Ta2O5 located 6 on the figure, having a null thickness. As in example 1, the two faces of the substrate are covered with the same stacking such as definite above.

[9,33] Simulation gave a coefficient of reflection (two treated faces) of 0,6%. On the sample, one measured 0,8%.

The tests of abrasion and chemical resistance also were excellent.

EXAMPLE N˚ 3

[9,39] The stacking of basic dielectric layers is made same elements as in example 2. Here, a cathode is equipped with a target of a tin and indium alloy which allows, in a known way to deposit a layer as conducting ITO.

[10,5] The substrate is a 2 mm thickness silico-sodo-calcic glass. It is intended to constitute the front face of a flat-faced screen. The basic stacking deposited on only one face has the following optical thicknesses (on the basis of the substrate of index 1,52):

1. - $TiO_2$ 34 Nm.
2. - $SiO_2$ 44 Nm
3. - $TiO_2$ 265 Nm
4. - $SiO_2$ 78 Nm

[10,14] On this stacking one deposits a fifth layer of ITO, index 2 and an optical thickness of 26 Nm.

[10,16] The reflection resulting from the interface glass-air is lower than 1% and the surface layer makes it possible to have an anti-static unit which avoids the deposit of dust.

[10,20] The calculation thickness of the additional layer 6, 16 does not require powerful means of calculation. Indeed, it was noted that the optical thickness - i.e. the product geometrical thickness by the index - of this last layer added to the optical thickness of the roadbase 4, 14 of stacking 5, 15 had the same value that would have the optical thickness of the only roadbase 4, 14 if one sought to optimize with one of the many methods available, the anti-reflecting performances of unit 5, 15 naked. Such an optimization provides besides for the first three layers 1, 2, 3; 12, 13, the 14 practically same values as in the three preceding examples where additional layer with relatively high index Sows was present.

[10,34] The invention shows, in particular on the three examples, that the fact of having like lays down surface of a stacking anti-reflecting a layer of rather high index, higher than 1,70 does not harm the anti-reflecting performances of the unit. One thus sees opening a broad choice of surface layers likely to give to the product performances ameliorees such, like, one saw it, that a chemical resistance, a behavior has abrasion, of the anti-static properties, etc...

CLAIMS

1. Anti-reflecting transparent product made up of a transparent substrate comprising on at least one of its faces a stacking (5, 15) of dielectric layers of indexes of refraction alternatively strong and weak, characterized in that stacking (5, 15) is covered with a layer (6, 16) additional a thickness higher than 5 Nm and whose index of refraction is higher than 1,70.

2. Transparent product according to claim 1, characterized in that the difference of the indexes of refraction respectively strong and low of the layers. dielectric constituting stacking is higher than 0,9.

3. Transparent product according to claim 1 or claim 2, characterized in that the stacking of dielectric layers (5, 15) comprises four layers.

4. Transparent product according to claim 3, characterized in that the sum optical thicknesses of the additional layer (6, 16) and of the roadbase (4, 14) of stacking (5, 15) is of the same order as the optical thickness that would have the aforementioned roadbase (4, 14) in the absence of the additional layer (6, 16) if stacking (5, 15) naked had been optimized for the best possible anti-reflecting effect, other layers of stacking (1, 2, 3; 12, 13, 14) remainder virtually identical.

5. Transparent product according to one of claims 1 to 4 characterized in that Your additional layer is a hard layer such as a layer containing oxynitrided of SiOxNy silicon or oxide Ta2O5 tantalum.

6 transparent Product according to one of claims 1 to 4, characterized in that the additional layer is a conducting layer of electricity such as a layer of ITO.

7 Process to deposit on a transparent substrate a whole of anti-reflecting interferential layers including/understanding the successive deposit of layers of indices alternatively strong and weak, characterized in that one finishes the deposit by a surface layer of superscript than 1,70.

8. Proceeded according to claim 7, characterized in that the successive deposit of layers of indices alternatively strong and weak is done with layers such as the difference of a strong index and a weak index that is to say higher than 0,9.

9. Proceeded according to claim 7 or claim 8, characterized in that the technique of deposit is cathode sputtering.

10. Application of the product according to one of claims 3 to 5 to the realization of windows.

11. Application of the product according to one of claims 3 to 5 to the realization of glasses.

12. Application of the product according to one of claims 3 to 5 to the realization of protective glazings of tables.

13. Application of the product according to claim 6 to the realization of front faces of screens, as private individuals of flat-faced screens.